A Unique Coax Gun Installation

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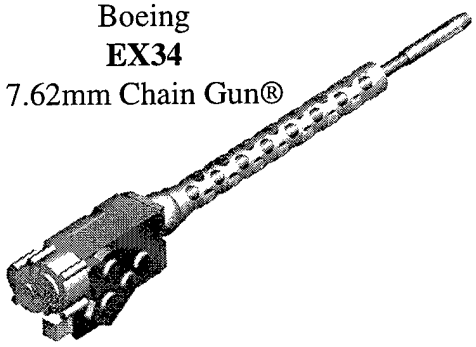
Introduction

Boeing
EX34
7.62mm Chain Gun®



- Overall Project: Bradley Up-gun
- 3-D CAD Model Layout
- Main Gun Solution Displaces Coax Gun
- Solutions for New Coax Installation
- Details of Selected Coax Solution
- Benefits

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Recently, Boeing Ordnance Engineering was tasked to design new armament installation for the Bradley Fighting Vehicle. The objective of this task was to increase the lethality and survivability of the Bradley without modifications to the existing turret structure and with minimal modifications to the supporting systems.

3-D CAD Models of the Bradley A2 turret were obtained from TACOM in IGES format. These models were used to setup a virtual design fixture to develop up-gun installation concepts.

The storage magazine used for the 35/50mm Bushmaster III installation displaced the 7.62mm coax gun. This created a new challenge to relocate a coax gun in the existing turret.

This paper describes a unique installation of the coax gun into the Bradley turret which allows the overall new system to include a 35/50mm Bushmaster III cannon with 22 ready rounds, a 62 round storage magazine for automatic quick upload of the ready magazine, and a 7.62mm coax gun in the existing turret structure of the Bradley.

Bradley Upgun Project

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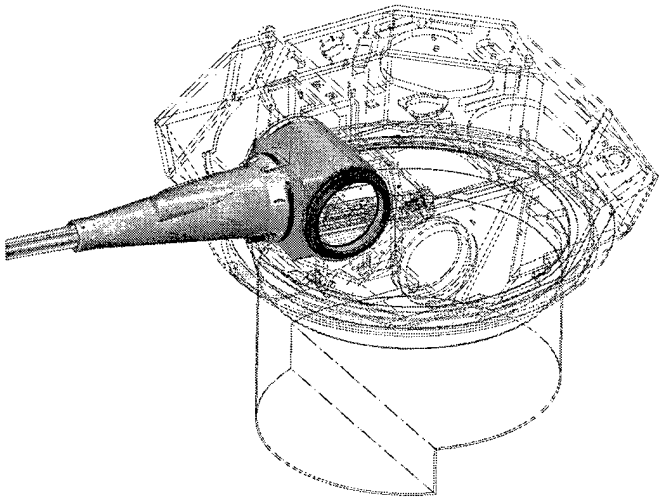
The Bradley Up-gun Project

Ground Rules:

- Do Not Alter Existing Bradley Structure
- Minimal Modification to Gun Support Systems
- Elevation Range +35°/-10°

3-D Solid Modelling
Bradley A2 Model from TACOM



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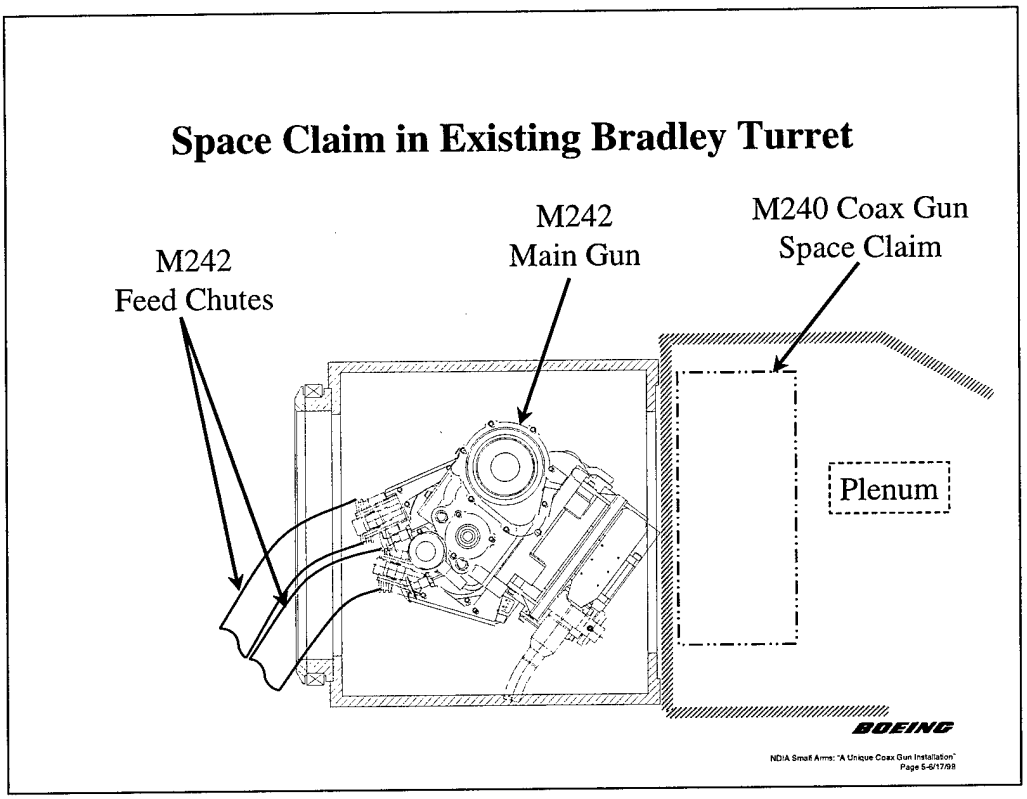
Boeing obtained 3-D CAD models of the Bradley A2 turret structure and system assemblies that are near the main gun space claim.

These models were used to construct a 3-D design fixture in Unigraphics.

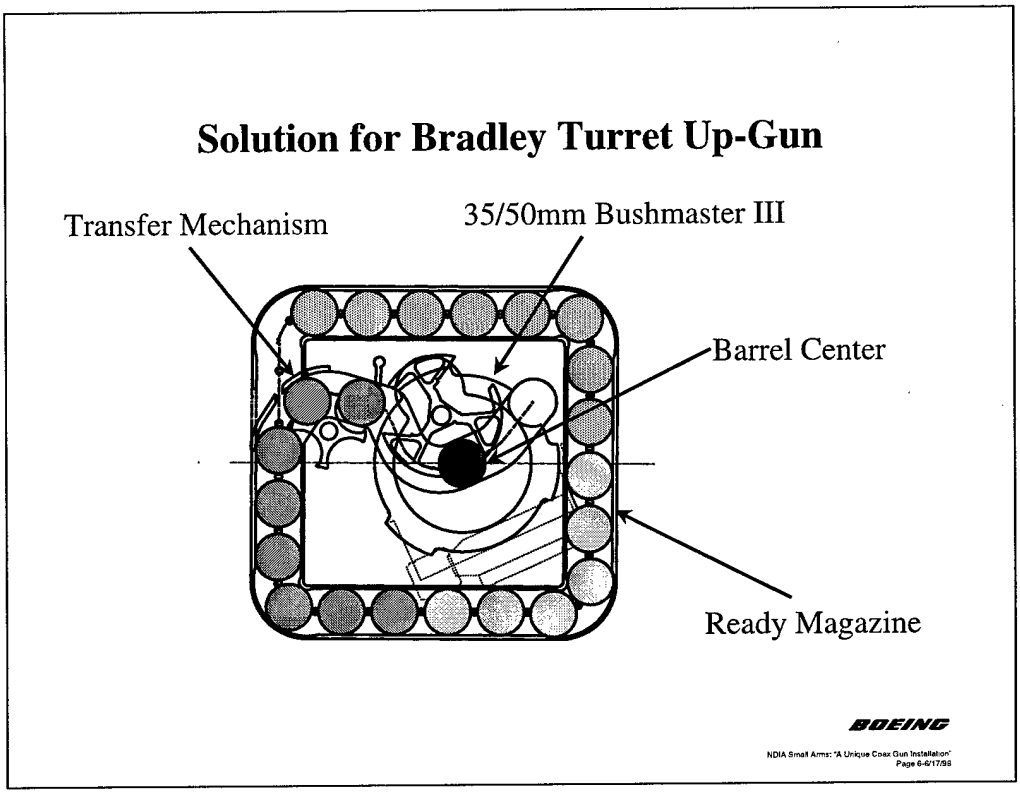
This fixture was used to layout and design potential concepts for main gun and coax gun installation. This method was very effective in investigating the effects of various concepts on Bradley sub-systems relative to space claim.

This method was proven successful when the 35/50mm Bushmaster III installation, which was designed using the turret model, was fabricated, installed, and fired out of an A2 Bradley.



The existing Bradley turret uses the M242 Bushmaster Cannon as the main armament. This gun is configured as a dual link fed gun. The gun is fed using flexible feed chutes (2) coming through the left trunion bearing. These feed chutes bring ammo from a magazine located on the turret basket floor. Spent cases are ejected forward and used links are ejected through the right trunnion bearing into the plenum chamber.

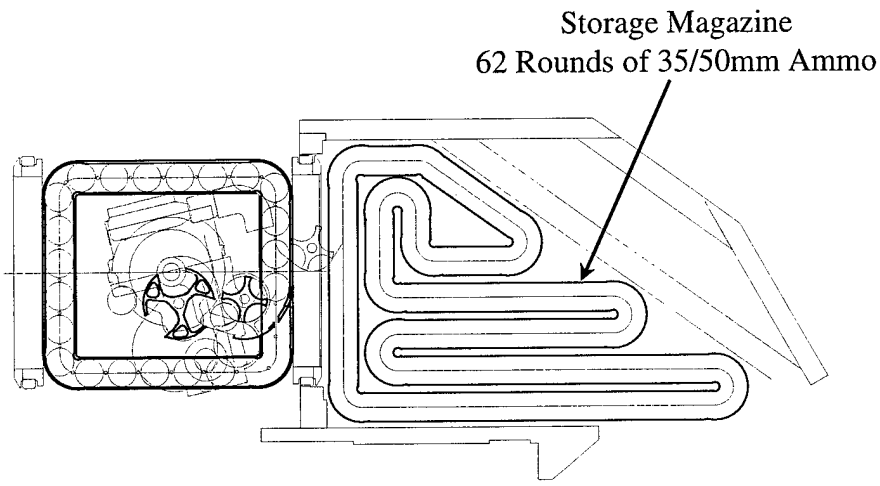
The coax gun is located in the plenum chamber and it's mount is fixed to the elevation rotor. The coax gun is fed using flexible feed chute which brings ammunition from magazines located in the crew compartment next to the commander. The feed is routed through an armor plate into the plenum chamber and up to the coax gun. The spent cases and used links are ejected into the plenum chamber.



After investigating many alternatives, a concept was chosen which best met the objectives of the task. A 35/50mm Bushmaster III gun is configured with a single linkless feeder. The gun is fed using a linear linkless ("chain ladder") magazine which wraps around Bushmaster III gun inside of the elevation rotor. A new elevation rotor is required but the turret structure itself is not altered to accommodate the new rotor.

This system provides a ready magazine capacity of 22 rounds of 35/50mm ammunition and a feed selection capability which permits the use of multiple types of ammunition. The new design also accommodates first round select, giving the gunner the selected nature of ammunition with the first round fired after a feed select. This system meets all design goals and ground rules set forth for the task.

Space Claim in Up-Gun Bradley Turret with 35/50mm Bushmaster III



• Storage Magazine Displaces M240 Coax Installation

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The next phase of the design was to determine feasible concepts for uploading the ready magazine. The method of uploading must be automatic ("hands off") and reasonably quick. Several concepts were investigated. One of the most favorable concepts uses the plenum chamber to house a linear linkless storage magazine. To upload the ready magazine, the elevation rotor is brought to horizontal. The two magazines are coupled together and the storage magazine feeds the ready magazine through the right trunion bearing. The same method is used to download the ready magazine into the storage magazine.

The storage magazine's most significant effect to the current system is that it displaces the coax weapon. This creates the necessity to investigate a new installation concept for the coax gun.

Proposed Solutions for Coax Installation

- Two options considered:
  - External to turret
  - Internal to turret
- Must be integral to the 35/50mm Bushmaster III
- Must not displace existing turret structure

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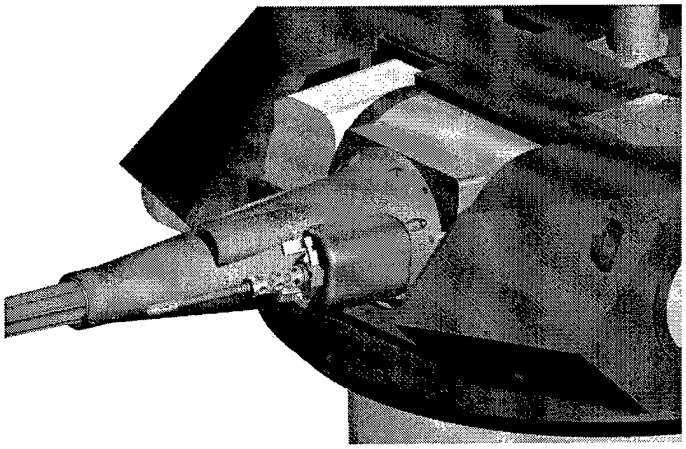
At the onset of the task to integrate a coax gun into the 35/50mm Bradley turret up-gun concept, the following goals were set forth:

1. The coax gun must be integral to the 35/50mm Bushmaster III. This approach will lead to the most efficient use of available volume. Existing weapon structure can be used to support the coax. Inclusion of coax into 35/50mm Bushmaster III space maximizes space use.
2. The installation must not displace existing turret structure.
3. Minimal effect on existing turret systems.

Two options were considered:

1. A gun and mount that was outside of the turret and thus remote from the crew.
2. A gun and mount that was inside of the turret with direct access by the crew.

External Mount Solution



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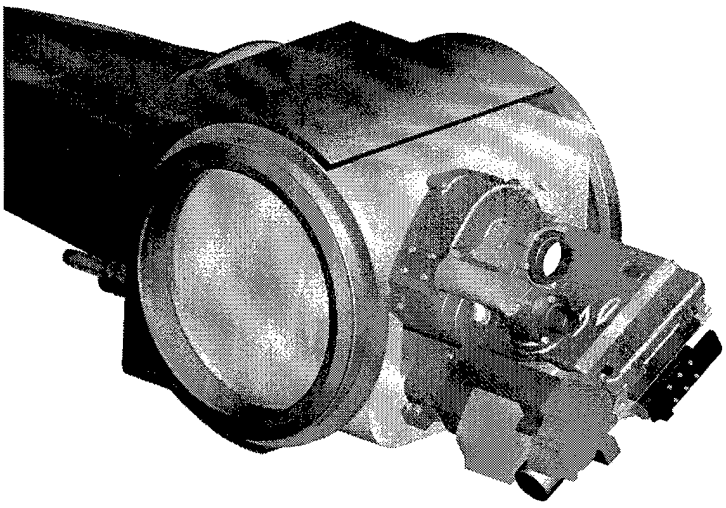
This approach is to mount the coax gun external to the turret. The EX34 can be mounted directly to the integral mount of the Bushmaster III. An armored access door encloses the gun, making it easily accessible.

This concept requires no additional modifications to the Bradley turret.

A feed chute would run from a magazine located inside of the turret through the Bushmaster III mount plate and integral mount to the coax gun. Links and spent cases would be ejected through a door in the bottom of the access panel.

Internal Mount Solution



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This approach mounts the coax gun inside the elevation rotor and inside of the ready magazine. Because the gun would now be directly in the crew department, the EX34 7.62mm Chain Gun® is ideal because it has a very low gun gas output.

By mounting the EX34 integrally with the Bushmaster III, maximum space use efficiency can be achieved.

The internal mount configuration does interfere with the existing elevation drive mechanism in the Bradley turret. A redesign of the elevation drive would be necessary to facilitate the internal coax installation.

Decision: Internal Mount Solution

Criteria	External	Internal
Effect on turret systems	None	Low
Access During Mission	Poor	Excellent
Vulnerability	Moderate	Low
Effect on Elevation Balance	Negative	Positive
Upload/Download	Remote	Direct
Design Complexity	Moderate	Low

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Effect on turret systems: The Internal Mount solution does interfere with a member of the existing turret elevation drive mechanism.

Access During Mission: The External Mount is a remote system with no access under armor. The Internal Mount gives direct access for all functions to the gunner from inside of the turret.

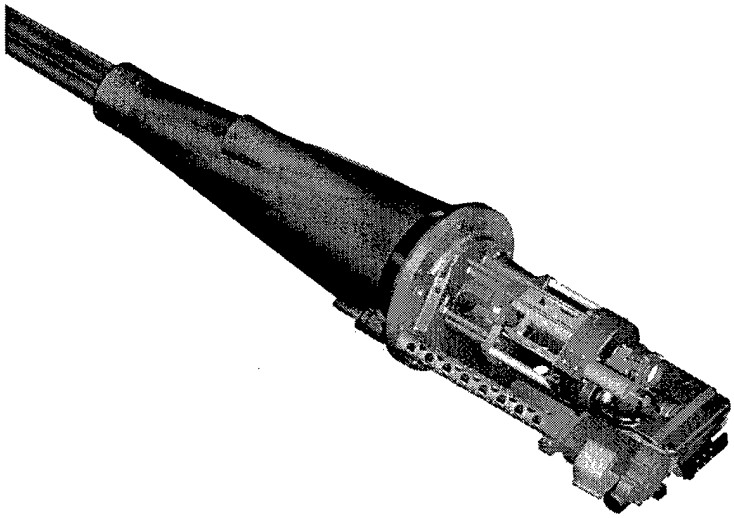
Vulnerability: Obviously, the External Mount is more vulnerable to small arms fire and artillery shrapnel.

Effect on Elevation Balance: The elevating mass is front-heavy on the 35/50mm Bushmaster III installation. This requires a heavy equilabrator to compensate. The External Mount adds to this problem, whereas the Internal Mount helps the problem.

Upload/Download: For obvious reasons the upload/download task is much simpler on the Internal Mount than on the External Mount.

Design Complexity: Adding the Internal Mount to the 35/50mm Bushmaster III Up-Gun concept adds only 5 new parts to the system, four of which are quite simple. The External Mount adds approximately 15 parts to the system.

Integrated To Bushmaster III



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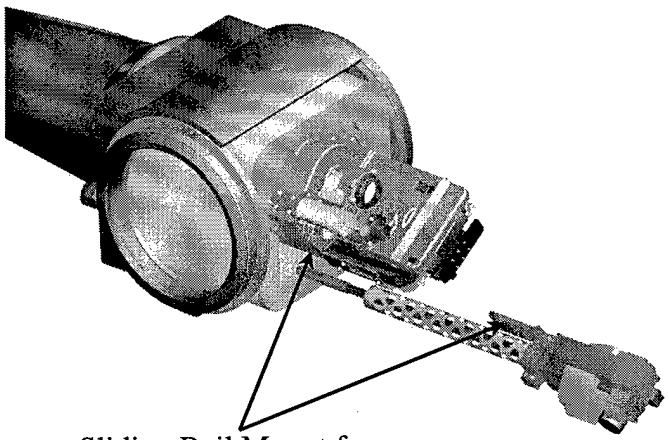
The Internal Mount 7.62 Coax gun is integral to the 35/50mm Bushmaster III. Very little additional volume is consumed by adding the 7.62 gun to the system.

Easy Removal of Coax From Installation



Sliding Rail Mount for
Quick Installation/Removal

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The coax gun mount uses a rail which mates with a support bracket located on the 35/50mm Bushmaster III receiver.

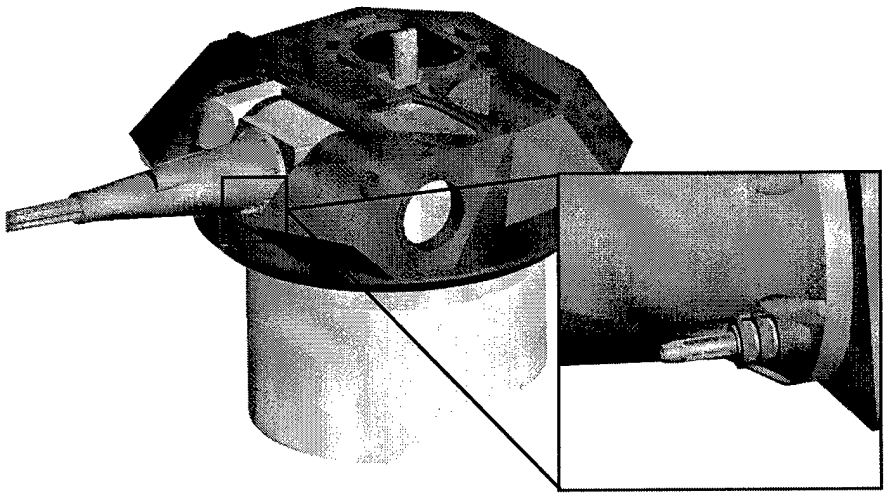
Installation of the coax gun is accomplished by simply aligning the coax gun from within the turret and inserting it forward. The front end of the barrel is guided through the inside of the wrap-around magazine and through the bore-sight mechanism. As the gun move forward the rail on the coax gun mount engages the mating rail on the Bushmaster III receiver. The coax gun is then pushed forward until it latches into its locked position.

Removal is accomplished by reaching under the coax gun to pull the mount-release pin and the sliding the gun aft while holding the mount-release pin out. The gun is then pulled aft until the barrel is clear of the wrap-around magazine.

No tools are required to install or remove the gun and the task is easily accomplished by one crew member.

Bore-sighting accuracy is assured since the sliding rail mount for the coax gun is fixed directly to the main gun.

Bore-sight Adjustment Outside of Turret



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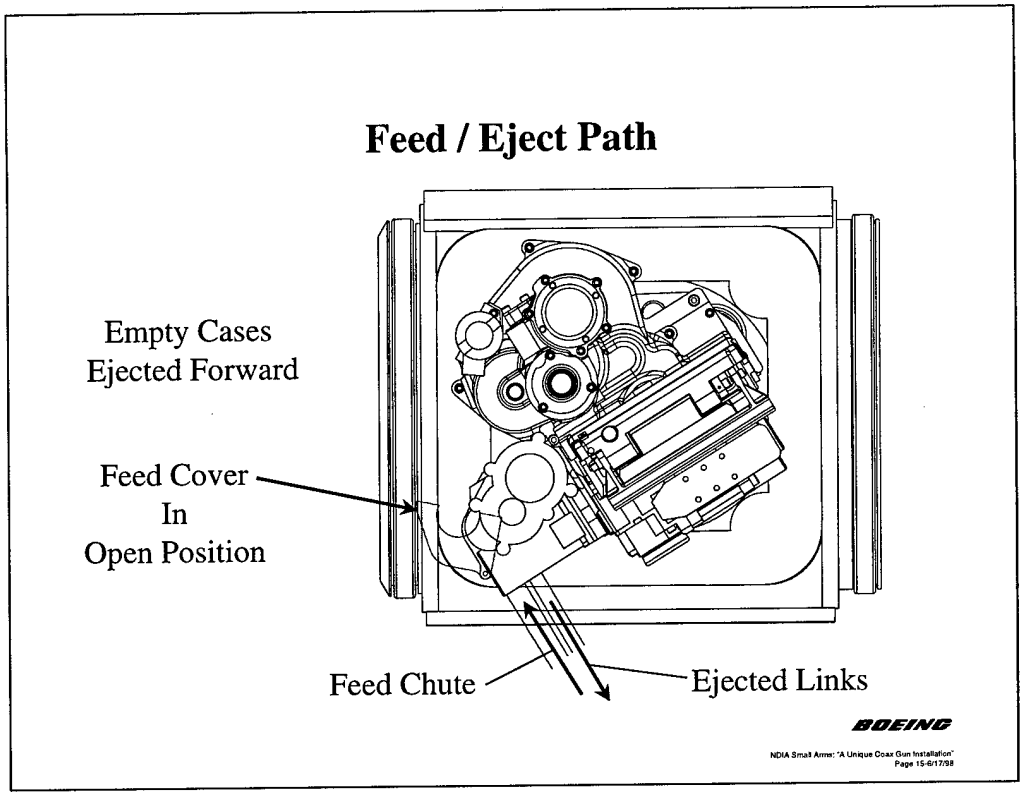
A bore-sight mechanism is contained in the coax gun forward mount housing. This housing is integral to the 35/50mm Bushmaster III integral mount. Two hex nuts are accessible from outside of the turret. These hex nuts provide adjustment of the coax guns aiming point in the vertical and horizontal planes.

The mechanism is spring-loaded and self-locking so that on person can easily use the bore-sight and adjust the aiming point at the same time. This reduces the bore-sight task to a simple task for one crew member.

Since the bore-sight mechanism is fixed to the main gun, their will be a very good repeatability of the bore-sight of the gun from one install/removal to the next.



The incoming feed and ejected links come into and leave the gun parallel to each other. The EX-34 is oriented such that the feed path is coming up to the bottom of the gun at about 30° from vertical. This is a versatile position as it allows the feed chute and ejected links to be routed virtually anywhere desired.

The empty cases can be ejected inside of the turret or they can be routed forward through the magazine and mount plate and ejected out the front of the turret.

Features and Benefits

- Simple Design
- Easy Installation and Removal
  - no tools required
- Easy Bore-Sighting Procedure
  - only one crew member required
  - bore-sight is accurate and repeatable
- Efficient use of valuable space inside of turret
- Easy access to coax weapon in turret
- Facilitates Upgrade of Main Weapon

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Summary

Successful Integration: 7.62 with Up-Gun Concept

Adds to Viability of 35/50mm As Practical Up-Gun

Integral Main Gun/Coax Gun Concept

Other Main Guns/Applications To Be Considered

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